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ABSTRACT

The Internet, for the purposes of this discussion, refers to the network that has the National Science Foundation Network (NSFNET) as its backbone. For this paper, internet is the larger connection of networks that provides a minimum basic connection for electronic mail. The network is made up of many segments structured in a multitiered hierarchy from the NSFNET backbone to the networks at participating institutions. Network operations centers and information centers provide for physical communications circuits, equipment servicing, and user support services. No one person or agency is responsible for the Internet/internet, but the system works as a result of a background culture and tradition that has developed over the years. There is a wealth of information available on how to use the Internet/internet as it exists, and a wealth of speculation about its growth in light of the planned National Information Infrastructure. Three figures, three maps, and five attachments illustrate the discussion. (Contains 11 references.) (SLD)

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What is the Internet, Who is Running It and How is It Used?

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What is the Internet, Who is Running It and How is It Used?

In order to understand the value of the worldwide Internet to our organizations it is useful to get a feel for what the Internet is and how it operates. It also is valuable to know who is running this thing that we are all becoming more and more dependent on every day. Therefore, we will try to lay a background about the Internet and follow that with a discussion of how the network is operated.

What is the Internet?

Let us define the Internet so that we can develop some boundaries for our discussion. A strict definition of the Internet might be, "the packet-switched network of networks unified by the TCP/IP protocol suite which share a common name and address space." This would include over 40,000 networks with unique IP addresses, some 1,000,000-plus hosts, and a generally agreed to millions of end users (no one knows the number for sure since there is no reliable way to count end users) in 120 - 130 countries worldwide.

However, for many users of the network this definition is too restrictive. An operational definition might include all those networked locations that can be reached from a networked workstation. By changing the term from Internet to internet, this larger definition, which includes those locations that can be reached via IP routing as well as those reached via various gateways, now gives a more complete representation of the "grapevine" that we use to communicate to our friends and neighbors, both near and far. In this sense the lower case internet includes many locations that do not have full IP connectivity but have as a minimum electronic mail capability across the network.

In the following we will be using Internet whenever we want to specifically refer to the network that has the National Science Foundation Network (NSFNET) as its backbone. We will use internet to mean that larger collection of networks that provide as a minimum basic connection for electronic-mail. As we continue this discussion other aspects of the internet will emerge.

Managing the Grapevine

Who is managing the network? The answer to that question may be "no one" or "everyone" depending on your point of view. Before we can talk about who is managing the network we need to understand some additional aspects of the Internet/internet. Therefore, to deal with this issue we will first look at the structure of the internet.

How is the Network Structured?

The network is not a monolithic structure; rather, as is implied from the above, the Internet/internet has thousands of segments. These segments are structured in a multi-tiered hierarchy. This structure is best demonstrated by the three-tiered network to which most libraries and institutions of higher education are currently connected.

The Top Level Of The Hierarchy

Our higher education/library communication hierarchy has the NSFNET as its highest level. The NSFNET is the main research and educational communication backbone in the USA. This is also the network that most people consider the primary backbone of the Internet. The NSFNET fully meets the requirements of being a packet-switched, TCP/IP protocol based network. Figure 1 shows the basic topology of the NSFNET backbone.

The NSFNET connects major super computing centers and a number of other locations in order to lay a communication net across the country. In addition, the NSFNET provides connections to the international community. Figure 1 also shows the connection to Canada (CA*net) and to Europe (CERN).

One can infer from this map that the backbone level of our hierarchy primarily connects major network nodes, such as super computer centers and switching centers. End user connections are supported at the lower levels of the hierarchy.

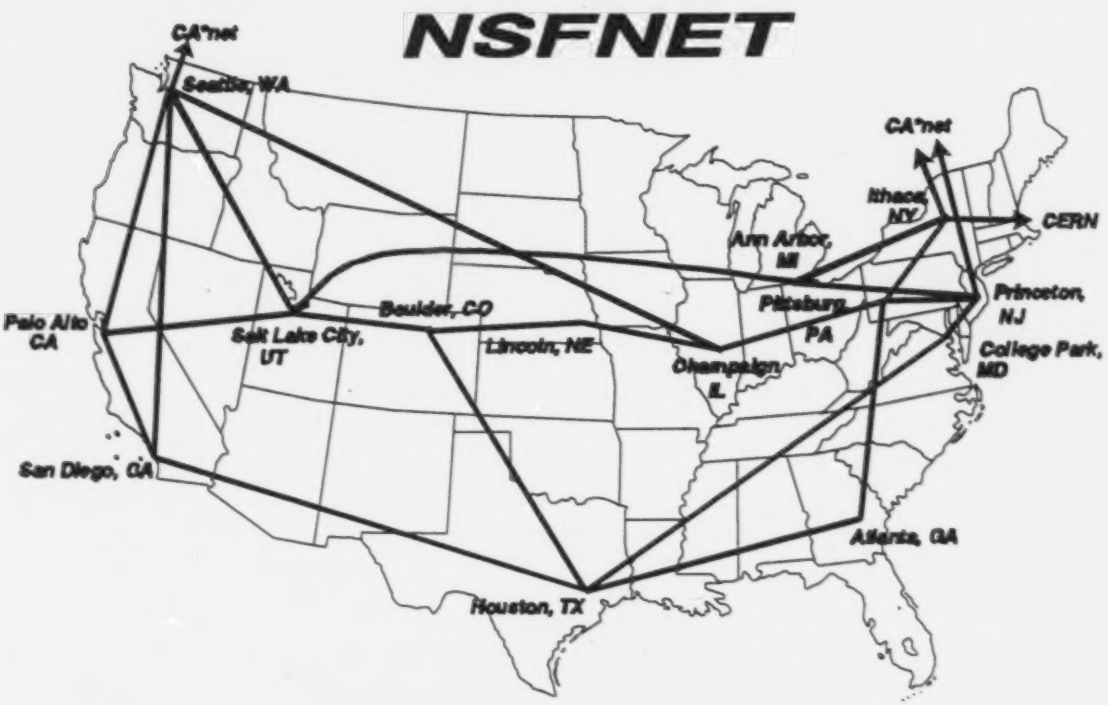


Figure 1

The Second Level Of The Hierarchy

The second level of the hierarchy is referred to as mid-level networks. These regional networks, sometimes just called "regionals," provide the connection path between the NSFNET backbone and the individual institutions that are connected to the Internet/internet. The following is a list of some of the prominent regional networks:

BARNet	Bay Area Regional Research Network (San Francisco); 419 723-3104
CERFnet	California Education and Research Federation Network; 619 455-3900
CICnet	Committee of Institutional Cooperation Network, Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Wisconsin; 313 998-6102
JVNCNet	John von Neumann Center Network, originally a super-computer access network, now a regional network serving mid-Atlantic states; 609 258-2400
Los Nettos	A regional network for Los Angeles area; 310 822-1511
MIDnet	A regional network for the Midwestern states, Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, Oklahoma; 402 472-5032
MRNet	Minnesota Regional Network; 612 342-2570

NEARnet	New England Academic and Research Network, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont; 617 873-8730
NorthWestNet	A regional network for the northwestern states, Alaska, Idaho, Montana, North Dakota, Oregon, Washington; 206 562-3000
NYSERNet	New York State Educational and Research Network; 315 443-4120
PREPnet	Pennsylvania Research and Economic Partnership Network; 412 268-7870
Sesquinet	Texas Sesquicentennial Network; 713 527-4988
SURAnet	Southeastern Universities Research Association Network, Alabama, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, North Carolina, South Carolina, Tennessee, Virginia, West Virginia; 301 982-4600
THEnet	Texas Higher Education Network; 512 471-5046
WESTNET	A regional network for the Rocky Mountain states, Arizona, Colorado, Idaho, New Mexico, Utah, Wyoming; 303 491-7260

To further illustrate the structure of this level of the hierarchy, the WESTNET regional network includes primary connections at the institutions listed below. However, keep in mind that each of these listed institutions serves as a central connection point/node for a number of additional educational institutions including K-12, community colleges and universities; city, county and state government agencies; as well as business and commercial organizations.

Arizona
Arizona State University
Northern Arizona University
University of Arizona

Colorado
Colorado State University
University of Colorado at Boulder
University of Colorado at Denver
University of Denver

Idaho
Boise State University

New Mexico
New Mexico Institute of Mining Technology
New Mexico State University
University of New Mexico

Utah
Brigham Young University
University of Utah
Utah State University

Wyoming
University of Wyoming

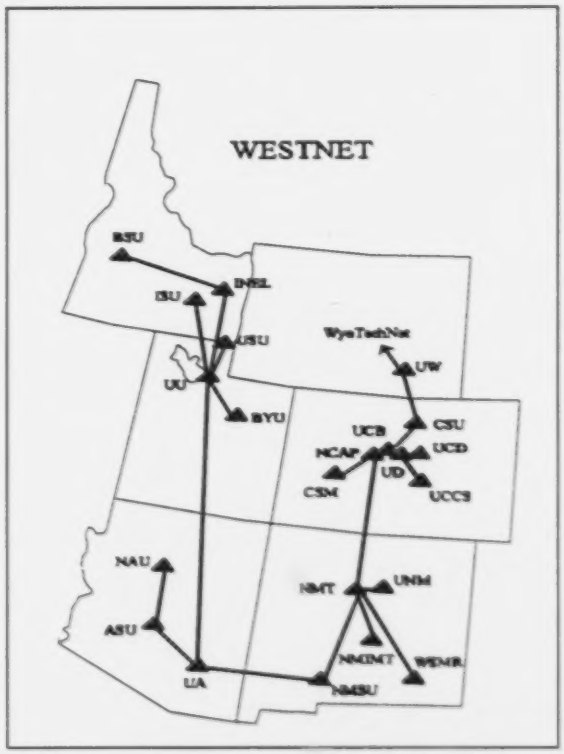


Figure 2

One can also see the continuity of connection between NSFNET and WESTNET as they appear in both Figure 1 and Figure 2. The two points that are common to both NSFNET and WESTNET are the UU at Salt Lake City and NCAR at Boulder.

The Third Level

Finally the third level of this hierarchy consists of the institutions' networks. These end-user networks comprise the connections where individuals' workstations get attached to the Internet/internet. Each of these institutions has a variety of hosts and/or one or more local networks that support the TCP/IP protocols necessary to allow its students, faculty, and staff to access the Internet/internet and participate in the information exchange that it provides. The key is the support for TCP/IP.

Keep this structure in mind as we now continue the discussion of "who is minding the store."

What does managing the network include?

At every level of the Internet/internet you will find Network Operation Centers (NOC) and Network Information Centers (NIC). These centers, along with the tools they use and support, are the basis for operation and management of the networks allowing end users to talk on the grapevine.

NOC Functions and Services

Without going into great detail we need to understand that NOCs provide for physical communication circuits and equipment installation, monitoring, repair, and trouble tracking that keeps the network operating. NOCs usually provide a set of services which are likely to include:

- Domain Name Service - a system that looks up address names and converts them to actual IP addresses that machines can use,
- Inventory and change control of communication equipment and circuits,
- Traffic data collection and analysis,
- Network engineering of changes and additions to the network and
- Interface with other agencies in the hierarchy (both higher level and lower level), telecommunication providers and equipment vendors on operational issues including network changes and operation restoration following an outage.

NIC Functions and Services

A NIC provides most other user support services. These services are likely to be loosely classified as consulting and training services. These services are the "high touch" services that give this "high tech" communication business its human dimension. Typically included in this set of services are:

- Preparing, maintaining, and distributing network user documentation,
- Generation and distribution of newsletters and other periodic publications,
- Providing documentation on end-user tools and information services available via network,
- Maintenance of information archives and
- Preparation and delivery of user training classes.

As you can see, the NOC is directed toward the technology, the physical systems that make up the network and its operation while the NIC is directed at the people using the network. Both are eminently important to the success of any network and one will find that there is overlap between these sets of functions in any particular network implementation. In fact it is not unusual in small networks to have one organization provide both NIC and NOC functions.

Who is in Charge?

We now come back to our initial question, "Who is managing the network?" No one person or agency is responsible for our Internet/internet. The component networks operate as a cooperating group of independently administered networks. Just as each Local Area Network (LAN) has its

systems administrator, each network that exists at each of the levels of our Internet/internet hierarchy has its policies, procedures, and administrative organization. THERE IS NO SINGLE, CENTRAL, OVERALL AUTHORITY FOR THE ENTIRE Internet/internet.

How can this possibly work given the size and complexity of the Internet/ internet? The system works as a result of a background culture and tradition that has developed over the years. In addition certain government agencies have historically taken leadership in developing policy that then is followed throughout the Internet/internet. These agencies have been able to establish their leadership role by a combination of knowledgeable decisions and by providing funding support for those decisions. Primary leadership has been provided by:

- The National Science Foundation
- The Administrator of the National Science Foundation Network
- The Administrator of the Defense Data Network

In addition to the government/funding agencies there is a large, very technically competent, basically volunteer group of individuals that guide the development of the Internet/internet. A group called the Internet Activities Board (IAB) is a central focus for the technical directions of the Internet. In order to extend this group to a more global scope, the IAB will be incorporated into the international Internet Society.

The IAB has an array of Task Forces, Areas, and Working Groups that develop solutions to identified technical problems. Once solutions are agreed upon by the larger networking community, the IAB recommends implementation. This results in new additions to the TCP/IP suite of protocols which are the basis for the Internet's operation. Finally each network site must implement the new standard. There is no mechanism for requiring a site or network to move to the new standard. However, lack of compliance may result in the loss of interoperability and ultimately isolation.

The net (no pun intended) of this discussion is that we now know that no single management agent runs the Internet/internet but that there is a lot of advice provided by knowledgeable sources on how it should be run. These sources recommend protocol standards, equipment functions, and types as well as end user policy and procedures. Cooperation among the many network managers is necessary to keep the Internet/internet operating and available.

<u>What kind of Traffic is on the Network?</u>

There are many types of traffic moving over the internet. The primary categories of communication traffic are:

- File exchange which you will hear referred to as FTP
- Electronic mail of various origins (based on SMTP standards)
- Interactive connection represented by TELNET (the connection of a workstation to a remote computer across the network)
- Name look-up using domain name service to find the IP address of a particular person or machine
- Miscellaneous other service

This traffic is generated as the millions of users review, update, and retrieve information from the 2,500,000-plus files that are publicly accessible via FTP at some nearly 1,000 locations on the network; as users participate in the 1,200 plus moderated Listserve conferences (many more are un-

moderated); as users browse the hundreds of library catalogs available on-line; and as users read and review the numerous journals, digests, and electronic newsletters on the internet. These information accessing activities are made easier by the use of tools such as GOPHER, the WORLD WIDE WEB, ARCHIE, VERONICA and many more. There are a large number of reference materials available to help one gain access to and experience with these tools. The following is a short representative list of good introductory references:

- "The Internet Companion - A Beginner's Guide to Global Networking" by Tracy LaQuey published by Addison Wesley
- "Internet Resource Guide" available on-line compiled by the NSF Network Service Center (nnsc@nnsc.nsf.net) at BBN Systems and Technologies, 10 Moulton St., Cambridge, MA. 02138.
- "New User's Guide to Useful and Unique Resources on the Internet" published by NYSERNet, Inc. (info@nysernet.org), 111 College Place, Syracuse, NY 13244-4100.
- "Zen and the Art of the Internet - A Beginner's Guide to the Internet" by Brendan P. Kehoe. Available both on-line and in major bookstores.
- "Internet Passport - NORTHWESTNET'S Guide to our World Online" published by NorthWestNet, 15400 SE 30th Place, Suite 202, Bellevue, Washington 98007.

The network activity generates huge amounts of traffic back and forth across the nation. In total, traffic reported across the NSFNET backbone in August 1993 was 37,826,679,000 packets up from 16,527,089,468 packets in August 1992. These numbers do not count traffic in local and regional networks that stays within the region and never reaches the NSFNET backbone. A recent report shows the following distribution of this traffic by service type.

Service	Percent of Packets
File Exchange	27
Network Mail	20
Interactive	15
Name Look-up	7
Miscellaneous	31

It should be obvious looking at these statistics that management of the internet is very important if the flow of information is going to continue. Every level of network management must do its part in order to keep this electronic access path open and functioning.

How Do New Institutions Become a Part of the Network?

There are two general types of connections that can be made to the network. An individual or institution can connect to the network via dial-up access to a connected network node. This type of connection may serve an individual relatively well, but probably will not provide adequate access for institutions. Therefore, we will not discuss the details of dial-up connections. We will only point out that there are a number of vendors of these internet dial-up services now operating in most major metropolitan areas.

The second type of connection allows an institution to become a full member of the network by becoming a node on the network. To become a network node an institution must be operating a host or local network which can support the TCP/IP protocols. The institution must install the

necessary network router (the gateway hardware that provides a connection to the internet) and routing software. The final hardware piece required is the actual communication circuit that connects the institution's router to the internet. In addition the institution must apply for a unique IP network number and establish its domain.

This seems rather complicated - where do you get IP numbers, where do you connect on the internet, what router make and model is required? These are all questions that the institution will need some help answering. Once again the historical, cooperative culture of the network is all important. The best place to start to get answers to the many questions is at the regional network (see the list above, telephone numbers included). The regional network office may be able to provide all the assistance needed, or they will be able to direct the query to the nearest logical connection node on the network. This is usually a nearby network connected university.

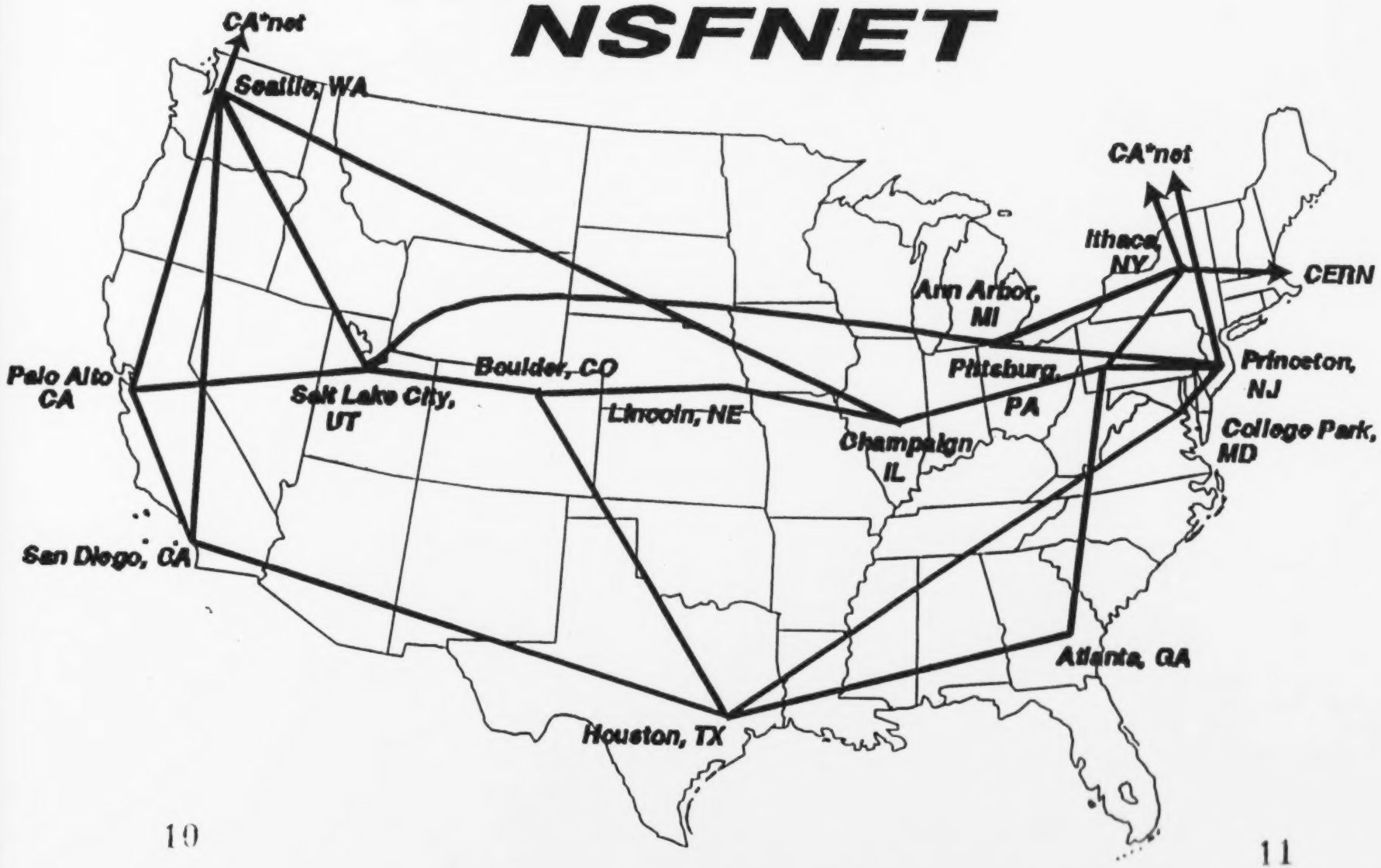
Most connected universities will have an information packet that includes the necessary forms and hardware recommendations as well as the detailed steps that you will need to accomplish in order to become connected. They may also supply the initial consulting help needed to get you started with establishing your NIC and NOC operations.

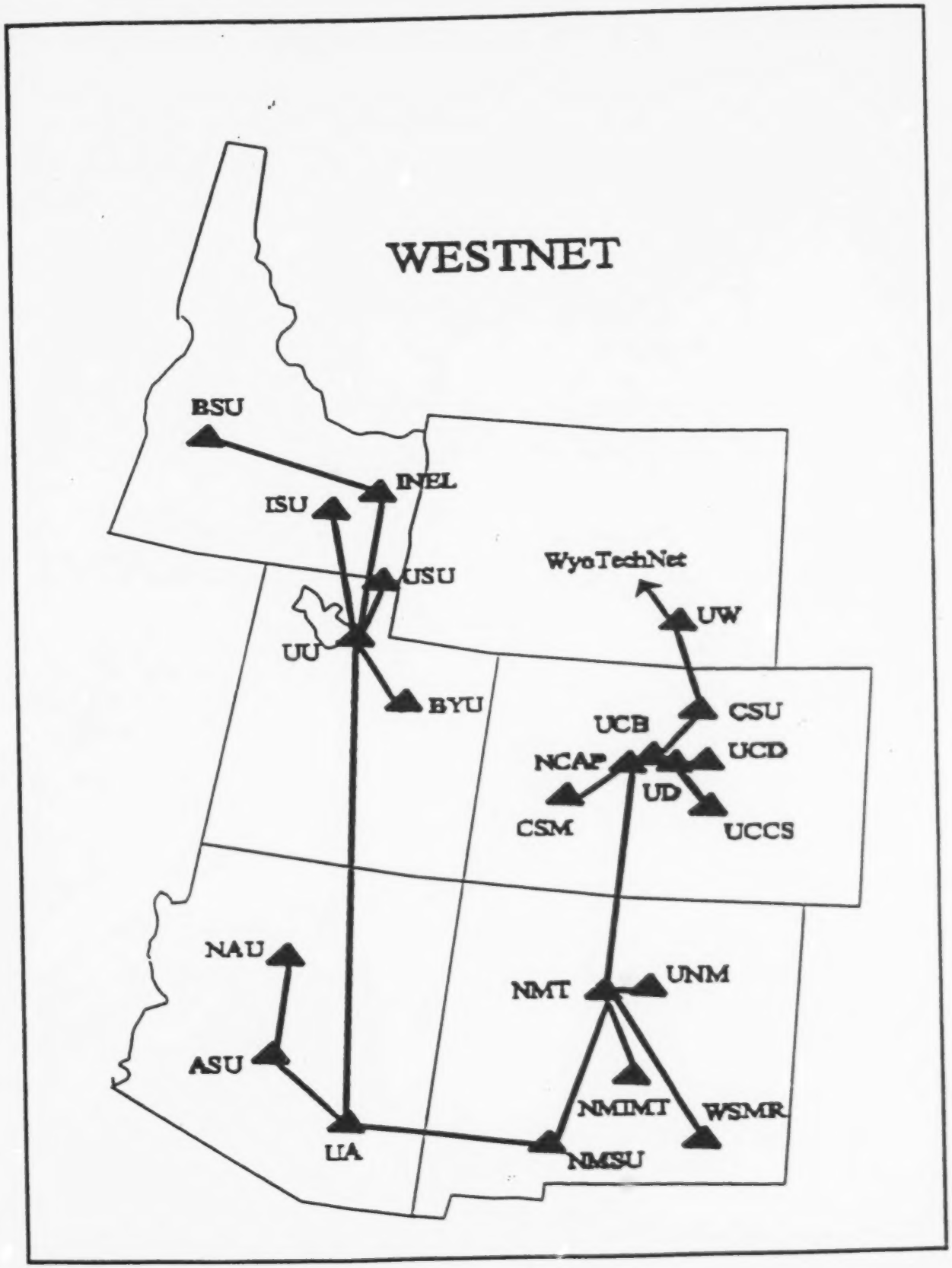
In addition there is a wealth of reference material that you may want to study before starting down the internet path. In addition to the references listed above, we can recommend "INTERNET: GETTING STARTED" by SRI International, Network Information Systems Center, 333 Ravenswood Avenue, Menlo Park, CA 94026, Telephone 415 859-6387.

Getting connected has its complications but asking a few questions will get you all the help you need. Network support staffs have a strong desire to expand the network since the value of all connections increase as more people and institutions are connected to the network.

Future Discussion

The Internet continues to grow in many ways. The number of connected host and workstations is going up and the concomitant growth in traffic is obvious from statistics quoted above. This network, which had been thought of as a research and educational network, now has a large number of commercial clients attached. The Clinton administration has big plans for a National Information Infrastructure. Congress wants to have a say in the development of the country's information highway as do the major communication vendors/suppliers. When will privatization and commercialization happen? What does all of this mean for the end user. Stay tuned -- we are all working to build the future. Carpe Diem.


NSFNET
CA*net
Seattle, WA
CA*net
Ithaca, NY
CERN
Ann Arbor, MI
Princeton, NJ
Pittsburg, PA
Boulder, CO
Palo Alto CA
Salt Lake City, UT
Lincoln, NE
College Park, MD
Champaign IL
San Diego, CA
Atlanta, GA
Houston, TX


WESTNET
BSU
INEL
ISU
USU
WyoTechNet
UW
UU
BYU
UCB
CSU
NCAR
UCD
UD
CSM
UCCS
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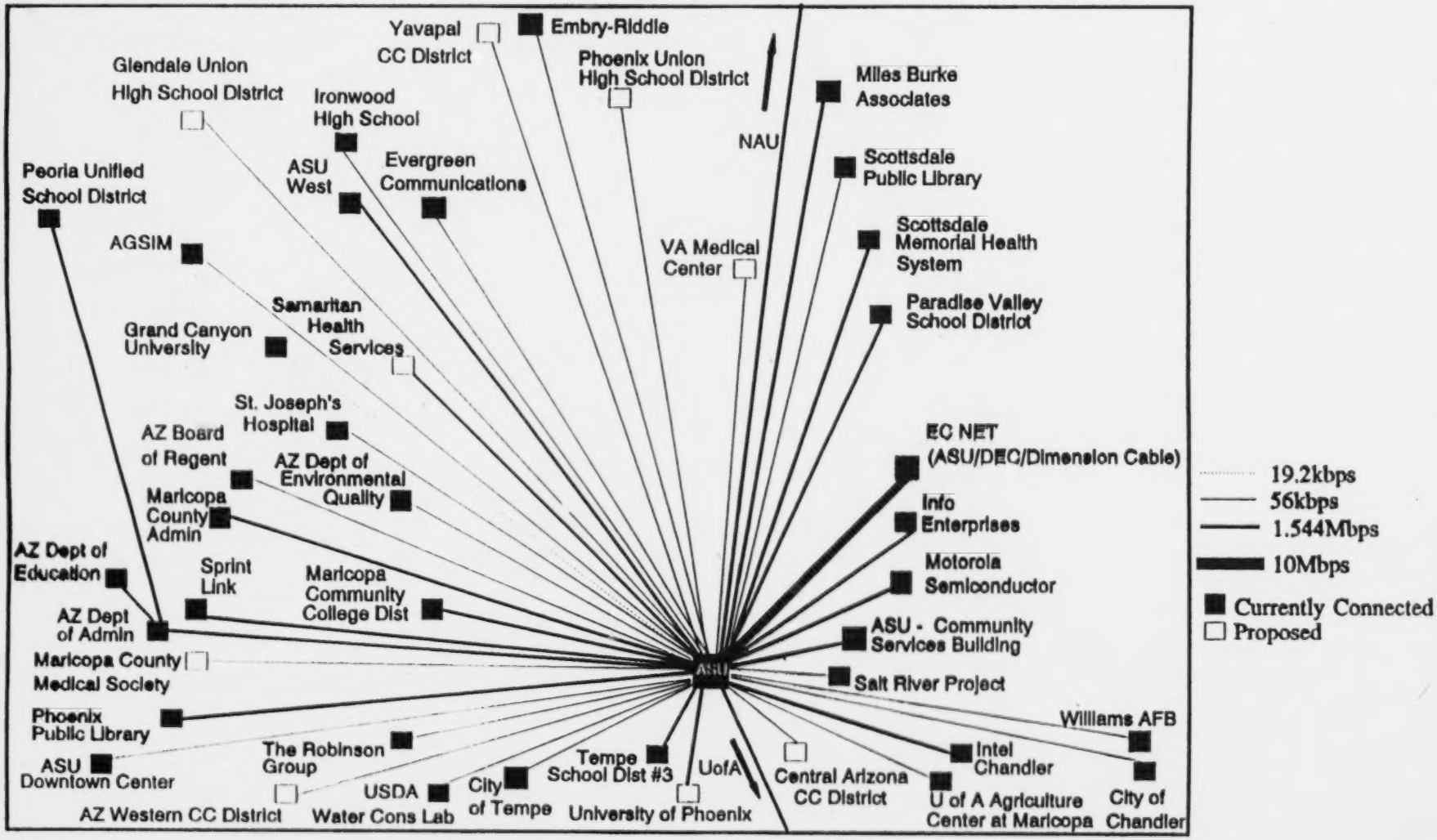
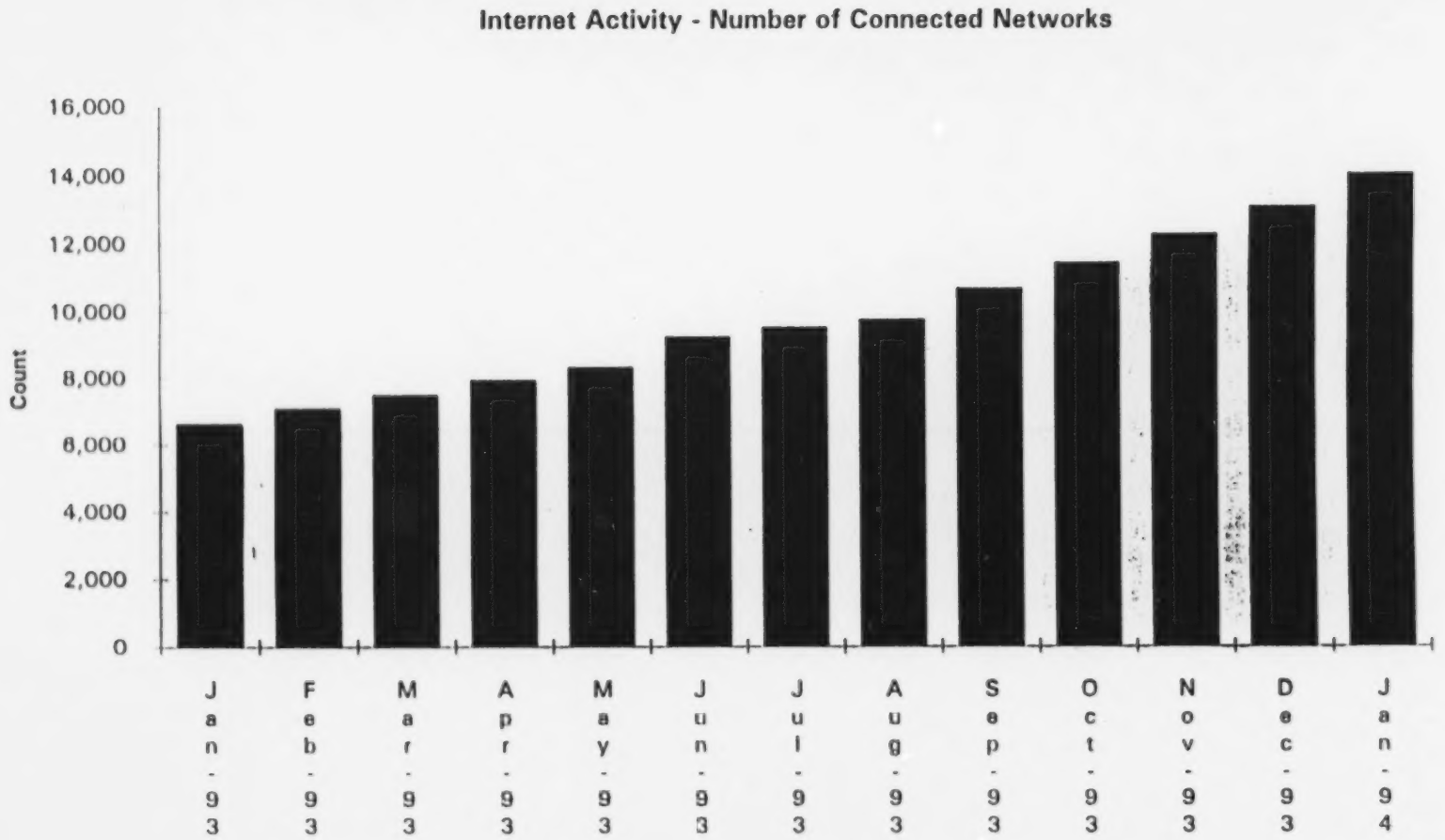
UNM
NMT
ASU
NMIMT
WSMR
UA
NMSU

Arizona State University
Westnet Connectivity
Detail

March 1994




Internet Activity - Number of Connected Networks
Count
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan-93
Feb-93
Mar-93
Apr-93
May-93
Jun-93
Jul-93
Aug-93
Sep-93
Oct-93
Nov-93
Dec-93
Jan-94

NSF Re solicitation

- NSF is moving to get out of the production network business by:
  - Establish a Very High-Speed Backbone Newtork Service for research and education only - the vBNS.
  - Establish Network Access Point (NAP) that can provide connectivity to the production network.
  - Establish a Routing Arbiter (RA) to provide a registry data base, the operations center and develop routing software.
  - Provide support for regional network service providers that will be phased out over the next five years.
- The vBNS has been awarded to MCI - $50,000,000 over 5 years.
- The RA has been awarded to Merit - $11,000,000 (operations) and joint venture USC/IBM - $9,000,000 (research and development).

NSF Re solicitation

- NAPs and Regional Provider Awards due soon.
- Five years form now . . . . ?

Cost

- One time cost of connection
- Ongoing costs
- Dial-up to the NSFNET
- Dial-up to commercial services
- Becoming a node on the Internet

Internet Information Retrieval Tools

Tool	Function	Information Available	Demo At:
Archie	Search & Retrieve	Review < 1.6 million files	archie.sura.net log in as archie
FTP	File Transfer	Gigabytes	all over the place
Gohper	Hierarchical Browser	More than 1,000 sites	consultant.micro.umn.edu log in as gopher
WAIS	Contextual Search and retrieval	more than 100 sites	quake.think.com log in as wais
MOSAIC	Framework for all tools	more than 100 sites	
WWW	Hypertext tool	more than 100 sites	info.cern.ch no login

Developing Applications

- Information, Communication, Supply Electozine
  Online Magazine from org_zine@wsc.colorado.edu
  A Student publication of Western State College, Gunnison, CO.

- IRS to expand electronic filing

- Delphi, the nation's fifth-largest on-line computer service purchased by Murdoch's News Corp. Indications that many of the company's magazines and newspaper will be made available over the Internet.

- Entertainment, entertainment, entertainment -
  RBOCs & Cable Companies & . . . . .

- Home education software sales are up 46% in first 3/4 of 1993 over 1992

- Blockbuster and IBM have produced a working model of interactive sales kiosks to sell and download movies, audio recordings, etc.

- Home shopping - Electronic shopping has grown to more than $3 billion annually and is predicted to rise to from $30 to $250 billion in the next 10 years.

- GTE and AT&T team up for a dial-up video demo in Manassas, VA. in 1995.

- AT&T is developing a gizmo, project Sage, that will allow routing of information from the NII to and from household electronics such as TVs, VCRs, PCs, FAX machines and video cameras.

- Digital Compression Technology boasts its new technology will enable 10 channels of video to be sent over existing copper telephone wires.

- North Carolina will connect 106 schools, prisons, hospitals and other state units bye AUG 1994.

- The American Association for the Advancement of Science has made its "Online Journal of Current Clinical Trials" available in its MEDLINE data base.

"If millions of Americans can't read, how can we expect them to log on to the Internet and on-line services?" Larry Magid in Washington Post.

An IBM sponsored Roper survey found that more than half of the respondents don't want a computer that requires a manual to use it.

One out of six Americans still can't set the digital clock on a vcr. Two years ago the number was one in five.

"The Information Superhighway? That sounds like place that's long and boring and kills 50,000 people a year." Dick Cavett at UCLA.

"The computer makes writing so easy that nobody has to think at all before knocking off a 500-pager. Result: The typical 500-pager nowadays reads a though nobody had thought at all. My suggestion: a new system warning writers that they have reached the 300-page mark and that going over 300 will produce a death-dealing electronic assault." Russel Baker, New York Times.

- The budget of the USA is now available in electronic format on CD-ROM.

- Ameritech, IL RBOC, will spend $4.4 billion for video servers, set-top boxes and fiber optic lines that will provide 1,000 channels of information. In peak periods most of the channels could be devoted to distributing a single movie.

- Ziff-Davis will offer the Interchange Online Network, carrying on-line versions of its publications (PC Magazine, PC Computing, PC Week, Mac User and Mac Week). Plans to be operational fall 1994.

- Palo Alto Weekly goes on-line on the Internet. 50,000 circulation published WED and FRI available at no charge.

- The market for on-line services is estimated at $800 million a year and growing at 25% annually.

- Nynex announced it will put its Yellow Pages on the Prodigy network. Will include traditional information plus pricing information, schedules and menus.

Clinton Administration's View of the Future

- VP Gore is on point.

- Defines the electronic superhighway as:
  "An elaborate network of electronic pathways on which electronic data can travel to PCs or smart TVs from any database or network in the nation."

- By JAN 2000 there will be connection to the NII in every:
  - Classroom
  - Library
  - Hospital

- Working on legislation, to be called Title VII of the Federal Communication Act, that will allow carriers access to each others facilities.

- There is a vague general vision of "Universal Data Service"

The Clinton administration has estimated the cost of building the NII at between $50 billion and $100 billion over the next 10 to 15 years. Industry experts say it could be double that, up to $200 billion by the time it is build.

Wall Street Journal writer Alan Murray warns that VP Gore's call for "universal service" on the NII smacks of one more entitlement for the middle class. Less than $1 billion will go to the needy.

LA firms wary of telecommunting even though travel is such a mess. Culture not ready to deal with employees that managers can not see. They also worry about insurance liability, lack of customer and co-worker interaction and extra equipment costs. However, one million more people are telecommuting this year than last year - an increase of 15%.

A Short List of Internet Resources - Additional Reading

- "The Internet Companion - A Beginner's Guide to Global Networking" by Tracy LaQuey published by Addison Wesley
- "The Internet Complete Reference" by Harley Han and Rick Stout, Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.
- "The Whole Internet User's Guide and Catalog" by Ed Krol, O'Reilly & Associates, Inc.
- "INTERNET: GETTING STARTED" by SRI International, Network Information Systems Center, 333 Ravenswood Avenue, Menlo Park, CA 94026, Telephone 415 859-6387.
- "Internet Passport - NORTHWESTNET'S Guide to our World Online" published by NorthWestNet, 15400 SE 30th Place, Suite 202, Bellevue, Washington 98007.
- "Internet Resource Guide" available on-line compiled by the NSF Network Service Center (nnsc@nnsc.nsf.net) at BBN Systems and Technologies, 10 Moulton St., Cambridge, MA. 02138.
- "New User's Guide to Useful and Unique Resources on the Internet" published by NYSERNet, Inc. (info@nysernet.org), 111 College Place, Syracuse, NY 13244-4100.
- "On INTERNET 94" edited by Tony Abbot published by Mecklermedia, 11 Ferry Lane West, Westport, CT 06880.
- "Zen and the Art of the Internet - A Beginner's Guide to the Internet" by Brendan P. Kehoe. Available both on-line and in major bookstores.
- "Newtwork World" and "Computer World" published by International Data Group Publication, 161 Worchester Rd., Framingham, MA 01701
- "Communications Week" and "Open Systems Today" published by CMP Publications, Inc., 600 Community Drive, Manhasset, NY 11030.

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